

REMARKS

Entry of the foregoing amendments and favorable reconsideration of the subject application is respectfully requested in view of the following comments.

Claims 1, 2, 5, 8 and 11 are currently pending in the subject application. Claim 1 has been amended herein in response to the examiner's rejections and claim 11 has been cancelled. Accordingly, claims 1, 2, 5 and 8 are herewith presented for the examiner's consideration.

In response to the examiner's comments in the Office Action, Applicants have cancelled claim 11. Accordingly, all objections and rejections with respect to claim 11 have been deemed moot.

Claim 1 has been amended to recite the value of "n" with respect to general formula (2) as being "0 or an integer of 2 or more in even numbers". Applicants respectfully submit that this narrower range for the value of "n" is fully supported by the specification as originally filed which discloses "n is 0 or integer of 1 or more" and, further, that this narrower range is indicative of the non-crystalline nature of the epoxy resin of general formula (2) obtained by indirect synthesis involving reacting liquid epoxy resin and an aromatic compound represented by general formula (1) as recited in claim 1, thereby distinguishing the present invention over the prior art of record.

No new matter has been entered by the foregoing amendments and entry thereof is respectfully requested.

Rejection of Claim 11 under 35 U.S.C. §112 first and second paragraphs

The Office Action rejects claim 11 under 35 U.S.C. § 112, first and second paragraphs as failing to comply with the written description requirement and as indefinite for failing to particularly point out and distinctly claim the subject matter which applicant regards as the invention.

In view of the foregoing cancellation of claim 11 herein, Applicants respectfully submit that the grounds for rejection of claim 11 under 35 U.S.C. §112, first and second paragraphs is moot and that no further argument in connection therewith is warranted.

Rejection of Claims 1, 2, 5, 8 and 11 under 35 U.S.C. §103(a)

The Office Action rejects claims 1, 5 and 11 under 35 U.S.C. § 103(a) as being unpatentable over Hartmann, U.S. Patent No. 4,153,621.

The Office Action further rejects claims 1, 2, 5, 8 and 11 under 35 U.S.C. § 103(a) as being unpatentable over Kawano, et al., U.S. Patent 7,063,914 (U.S. Pub. 2003/0175571) in view of Hartmann, U.S. Patent No. 4,153,621. The Office Action states:

Hartmann (col. 3, lines 1-41) depicts a tetraalkylbiphenol-advanced diglycidyl ether of tetrahydrocarbylbiphenol wherein the repeating unit quantified by "n" is the identical range as claimed of 0 or more (col. 3, line 24). The extent of "n" embraces higher values leading to higher molecular weights and higher epoxy equivalents (col. 3, lines 38-

41). It would have been obvious to react the epichlorohydrin and biphenol at a ratio towards 2:1 to attain a weight average molecular weight and epoxy equivalent within the confines of claim 11.

Kawano et al (col. 2, lines 22-40) shows a tetrahydrocarbylbisphenol F advanced diglycidyl ether of tetrahydrocarbylbisphenol F of general formula (1) conforming to the claimed general formula (2) wherein X is $-\text{CH}_2-$ and the repeating unit quantified by "n" is from 0-15 embraced by the claimed value for "n" of 0 or more. The epoxy resin of general formula (1) of Kawano et al. inherently possesses a weight average molecular weight and epoxy equivalent within the parameters of claim 11 based on the equivalent epoxy resin structure and value for the repeating unit "n".

Hartmann et al. in column 10, lines 5-8 shows a noncrystallized diglycidyl ether of 3,3',5,5'-tetramethylbiphenol (col. 9, Example 1, lines 17-18). Although the epoxide equivalent of 272 is lower than that required in claim 11, it is well within the purview of patentees to prepare a diglycidyl ether of tetramethylbiphenol with a higher weight average molecular weight and epoxide equivalent to within the claimed limits by reducing the epichlorohydrin:3,3',5,5'-tetramethylbiphenol ratio from the 10:1 employed in Example 1 to the 2:1 disclosed in column 3, lines 38-41.

Column 5, lines 35-40 teaches the extension of the diglycidyl ethers of tetraalkylbiphenols with aromatic dihydroxy compounds to form higher molecular weight prepolymers. It would have been obvious to extend the diglycidyl ether of tetraalkylbiphenol of Hartmann with an aromatic dihydroxy compound such as a tetraalkylbiphenol to yield a higher molecular weight prepolymer within the boundaries of claim 11.

Claims 1, 2, 5 and 8 are directed to a non-crystalline epoxy resin of general formula (2) obtained by reacting a liquid epoxy resin and aromatic dihydric phenol compound of general formula (1), thereby constituting a product-by-process claim.

According to MPEP § 2113, "Product-by-Process Claims."

"[E]ven though the product-by-process claims are limited by and defined by the process, determination of patentability is based on the product itself. The patentability of a product does not depend on

its method of production. If the product in the product-by-process claim is the same as or obvious from a product of the prior art, the claim is unpatentable even though the prior product was made by a different process." *In re Thorpe*, 777 F.2d. 695, 698, 227 USPQ 964, 966 (Fed. Cir. 1985).

"Once the examiner provides a rationale tending to show that the claimed product appears to be the same or similar to that of the prior art, although produced by a different process, the burden shifts to applicant to come forward with evidence establishing an unobvious difference between the claimed product and the prior art product. *In re Marosi*, 710 F.2d. 798, 802, 218 USPQ 289, 292 (Fed. Cir. 1983)."

The formula for the tetraalkylbiphenol-advanced diglycidyl ether of tetraalkylbiphenol illustrated in columns 3-4, about lines 1-10 is embraced by the claimed general formula (2). There is no evidence of record establishing an unobvious difference between the prior art and claimed diglycidyl ethers of 3,3',5,5'-tetramethylbiphenol.

Nowhere is there any characterization in Kawano et al. of the tetrahydrocarbylbisphenol F advanced diglycidyl ether of tetrahydrocarbylbisphenol F of general formula (1) as crystalline (col. 2, lines 22-40). The teachings of a reference are not confined to the examples. Although the exemplified tetramethylbisphenol F epoxy resin YSLV-80XY (col. 7, lines 59-61) is designated as crystalline on page 10, Reference Example 1 of the instant specification, the identification of a softening temperature range from 75-80°C as opposed to a distinct melting point indicates the amorphous nature of the polymer, thereby establishing a non-crystalline state. Note that Reference Example 1 further manipulates the YSLV-80XY by heating to fusion and mixed with a diglycidyl ether of 3,3',5,5'-tetramethyl-4,4'-dihydroxydiphenyl prior to crystallization, which is not representative of the untreated YSLV-80XY in Kawano et al.

The motivation to prepare higher molecular weight diglycidyl ethers by reacting the epichlorohydrin and dihydric phenol at a molar ratio towards 2:1 is affirmatively set forth in column 3, lines 38-41 of Hartmann and is not based on hindsight. It would have

been obvious to form the diglycidyl ethers of Hartmann et al. and Kawano et al. at molar ratios of epichlorohydrin to dihydric phenol approaching 2:1 in order to produce predominantly higher molecular weight diglycidyl ethers to the exclusion of the monomeric species wherein $n=0$ to within the extent of 60% or less required in claim 1.

With regard to the rejection of claim 11 and the examiner's reasoning therefore as applied above, Applicants respectfully submit that the cancellation of claim 11 has rendered all rejections thereof moot.

As the foregoing rejections apply to claims 1, 2, 5 and 8, Applicants respectfully traverse those rejections on the ground that a *prima facie* case of obviousness has not been established with respect to the presently pending claims.

The Federal Circuit has ruled that a *prima facie* case of obviousness must establish: (1) some suggestion or motivation to modify the references; (2) a reasonable expectation of success; and (3) that the prior art references teach or suggest all claim limitations. Amgen, Inc. v. Chugai Pharm. Co., 18 USPQ2d 1016, 1023 (Fed. Cir. 1991); In re Fine, 5 USPQ2d 1596, 1598 (Fed. Cir. 1988); In re Wilson, 165 USPQ 494, 496 (C.C.P.A. 1970).

A *prima facie* case of obviousness must also include a showing of the reasons why it would be obvious to modify the references to produce the present invention. See Ex parte Clapp, 277 USPQ 972, 973 (Bd. Pat. App. & Inter. 1985). The examiner bears the initial burden to provide some convincing line of reasoning as to why the artisan would have found the claimed invention to have been obvious in light of the teachings. Id. at

Applicants respectfully submit that a *prima facie* case of obviousness has not been established as there is no motivation in the prior art to lead one of ordinary skill in the art to modify the teachings of Hartmann, or of Kawano, et al, in view of Hartmann, to obtain the non-crystalline epoxy resin of the present invention when the thrust of those teachings is toward crystalline resins having significantly different properties. Nor is there any suggestion in the prior art of record which would lead one to have an expectation of success with such a modification. Finally, the references fail to disclose or suggest all of the recited limitations of the present claims

With regard to the rejection of claims 1 and 5 as unpatentable over Hartmann, Applicants note that Hartmann discloses a general formula of diglycidyl ether of tetraalkylbiphenol (column 3, lines 1-41) which is obtained by a reaction between tetraalkylbiphenol and epihalohydrin, the direct synthesis method. In contrast, the advanced method of the present application reacts a divalent phenol and a divalent epoxy resin in a process of indirect synthesis between liquid epoxy resin and the aromatic compound represented by general formula (1) as recited in claim 1. In the case of direct synthesis as disclosed by Hartmann, the polymerization degree "n" of the obtained resins is $n=0, 1, 2, 3, 4, 5$, etc., whereas the indirect synthesis of the present invention results in a polymerization degree "n" of the obtained resins of $n=2, 4, 6, 8$, etc. Thus,

although the general formula for the respective resins may be the same, the distribution of the molecular weights of the resins of the respective processes is different resulting in different products with different properties.

This distinction is demonstrated by the experiments conducted by the co-inventors herein, Shuya Shinohara, Masayoshi Hanabusa, Nobuhisa Saito and Hiroshi Nakanishi, and presented in the accompanying Declaration Under Rule 132 wherein it is shown that the resin of Hartmann is crystalline whereas the resin of the present application is non-crystalline as determined by their respective melting points and latent heat quantities measured by differential scanning calorimetry.

Tests on the resin of Hartmann use the resin of Example 1 of the reference as disclosed at column 9, line 15 to column 10, line 17. In these tests, epoxy resin A corresponds to the product obtained from the slurry of 3,3',5,5'-tetramethylbiphenol (TMBP) and epichlorohydrin which is filtered, washed and dried to produce a resin having an epoxide equivalent of about 190 and a melting point of 97°-102°C. As shown in Table 1 of the Declaration, epoxy resin A of Hartmann has a melting point of 103.8°C, a latent heat quantity of 75.6 mj/mg and does not exhibit a glass transition temperature, all of which are indicative of a crystalline structure. Furthermore, gel permeation chromatography shows that epoxy resin A has a content ratio of n=0 component of 88% which is well in excess of the 60% or less for the present invention as recited in claim 1. Taken

with the specific disclosure of Hartmann at column 9, lines 38-40 which states "All of the methanol was added when the temperature was at 46°C at which point the product began to crystallize.", it is clear that epoxy resin A of example 1 is a crystalline product having an epoxy equivalent of about 192 and an n=0 component in excess of 60% such that the higher component of "n" is n=1. This product clearly does not correspond to the non-crystalline epoxy resin of the present invention as recited in claim 1 nor would the present invention be obvious therefrom since the process used by Hartmann will consistently produce such a crystalline product with the lower epoxide equivalent and higher component of n=0 rather than the non-crystalline resin represented by claim 1 herein. It is noted that the epoxy resin A of Example 1 of Hartmann is the same for Examples 2-4 as disclosed in the reference.

Furthermore, as previously noted by Applicants, the products of examples 6, 8 and 9 of Hartmann are also crystalline as shown by the following passages from the reference:

In Example 6, col. 10, lines 29-30, "Methanol (1500ml) was added while crystallization took place."

In Example 8, col. 11, lines 59-63, "The product was filtered while hot and purified TMBP-DGE was then crystallized by cooling and storage at 0°C. The recrystallized diglycidyl ether was isolated by filtration and washed with methanol (4x100ml)."

In Example 9, col. 12, lines 37-38, "Crystallized

product was filtered and washed with cold cyclohexane/chlorobenzene."

In addition, the resin product of Example 7, also obtained by the direct process of reacting TMBP with epihalohydrin, although not specifically identified as such, exhibits crystalline properties, having a melting point of 107°C and an epoxide equivalent of about 184.

Accordingly, it is clear that the epoxy resin products of Examples 1-4 and 6-9 of Hartmann, fail to disclose the resin of the present invention and fail to support the examiner's contention that the claimed resin as produced by the indirect method would be obvious to one of ordinary skill in the art.

As for Example 5 of Hartmann, Applicants point out that this example uses the residual fraction left over following extraction of epoxy resin A as disclosed in the reference. Returning to the Declaration, it is noted that epoxy resin B corresponds to the non-crystallized menthol soluble residual fraction corresponding to the filtrate separated from the product of epoxy resin A. As noted, epoxy resin B is a viscous liquid having an epoxy equivalent of 272, but exhibiting a ratio of $n=0$ component of 62.2% which is in excess of that recited in claim 1 herein. Furthermore, as shown by the gel permeation chromatography results in Table 1, the higher components of "n" for epoxy resin B are non-ring closure components and $n=1$, not the aromatic component of general formula (2) where n is 0 or an integer of 2 or more in even numbers. The only property that this residual

fraction has in common with the claimed resin is an epoxy equivalent in excess of 250, however this alone is insufficient to cure the other deficiencies exhibited by epoxy resin B relative to the claimed invention. Furthermore, there is no discussion in Hartmann to suggest applying this residual fraction, or indeed epoxy resin A, in an indirect process with an aromatic compound of general formula (1) to obtain the non-crystalline epoxy resin of the present invention as recited in claim 1.

In view of the foregoing, it is clear that the specific examples of Hartmann fail to disclose or suggest the non-crystalline epoxy resin prepared by the indirect process as recited in claim 1.

The examiner suggests that Hartmann teaches the extension of the diglycidyl ethers of tetraalkylbiphenols with aromatic dihydroxy compounds to form higher molecular weight prepolymers and that it would be obvious to form the diglycidyl ethers of Hartmann at molar ratios of epichlorohydrin to dihydric phenol approaching 2:1 in order to produce predominantly higher molecular weight diglycidyl ethers to the exclusion of the monomeric species wherein $n=0$ is within the extent of 60% or less. However, Applicants respectfully submit that Hartmann fails to teach or suggest that such extended diglycidyl ethers of tetraalkylbiphenols be limited to resins where the value of "n", when not 0, is 2 or more in even numbers thereby guaranteeing that the resulting epoxy resin is non-crystalline. Indeed,

applying the examiner's suggestion to the only specific teachings in the reference would lead one of ordinary skill in the art to expect that the resulting resins would continue to be crystalline as higher molecular weight versions of the specifically taught products.

Although the teachings of a reference are not limited to the examples, the examples do provide guidance and motivation to understand the direction of the teachings. In the case of Hartmann, there is nothing to guide one away from the crystalline resin forms of the examples and toward the non-crystalline resin recited in the present claims.

Thus, even with a general depiction of a tetraalkylbiphenol-advanced diglycidyl ether of tetrahydrocarbylbiphenol, absent some suggestion that such products may undergo further processing with an additional aromatic compound corresponding to the present claims and resulting in a non-crystalline epoxy resin having the claimed molecular weight distribution and where n is 0 or an integer of 2 or more even numbers, the content of $n=0$ component is 60% or less and the epoxy equivalent is 250g/eq or more of the present invention, Applicants respectfully submit that the degree of experimentation required of one of ordinary skill in the art to modify Hartmann to obtain the present invention is beyond that which could be reasonably said to be obvious in view of the fact that the only clear teachings of the reference direct one to crystalline resins. Accordingly, Applicants respectfully submit that a *prima facie* showing of obviousness with respect to claims

1 and 5 in view of Hartmann has not been made and that the examiner's rejection is without support and should be withdrawn.

With regard to Kawano, et al., it is noted that the reference discloses general formula (1) whose "n" is 0-15. However, Applicants respectfully point out that the reference is particularly directed to a fuel cell separator which comprises a resin binder having a particular viscosity, graphite particles and a curing accelerator and would not likely be readily considered by one of ordinary skill in the art looking for teachings related to non-crystalline epoxy resins and their methods of production. In addition, Applicants note that the reference teaches the epoxy resin for the disclosed utility is preferably a bisphenol F type epoxy resin represented by general formula (1) or an alkylbisphenol F type epoxy resin represented by formula (2) at column 4, lines 25-40. There is no disclosure or suggestion in Kawano, et al., of such a resin obtained by the indirect method and having the properties recited in claim 1.

As Applicants have previously pointed out, Kawano, et al., at best, follow the direct method of Hartmann by epoxidizing bisphenol F or a substituted bisphenol F with epihalohydrin (col. 4, lines 41-46). Accordingly, it would be expected, based on the teaching of Hartmann, that the resulting epoxy resins would be crystalline and would not conform to the limitations as set forth in claim 1 herein.

In that regard, the examiner contends that nowhere is there any characterization in Kawano, et al., that the

tetrahydrocarbylbisphenol F advanced diglycidyl ether of tetrahydrocarbylbisphenol F is crystalline. However, Applicants point out that neither does the reference characterize the epoxy resin as non-crystalline, whereas there exists teaching to suggest, as in the case of Hartmann, that the resins used in the reference are crystalline. In that regard, Applicants respectfully direct the examiner's attention to the herewith filed Declaration wherein it is shown that the tetramethylbisphenol F epoxy resin YSLV-80XY identified in Kawano, et al., and described in the present application in connection with Reference Example 1 at page 10, line 25 to page 11, line 3, is indeed a crystalline resin exhibiting a melting point of 68.5°C and a latent heat quantity of 76.6mj/mg. Furthermore, the ratio of n=0 component is 93.6%. As noted in the Declaration, YSLV-80XY (Lot No. 4 7M003) is the same commodity as in Example 2 of Kawano, et al. Although originally a product of Nippon Steel Chemical Co., Ltd., YSLV-80XY is now produced by Tohto Kasei Co., Ltd., the assignee of the present application and, as such, the Applicants herein are well positioned to determine the properties of this resin. As stated in the Declaration, YSLV-80XY exhibits a slow rate of crystallization such that immediately after production it has the appearance of a non-crystalline resin. Crystallization of YSLV-80XY is known to progress at a very slow rate at room temperature, taking from several days to one month to complete crystallization. Until that happens, YSLV-80XY will exhibit a

softening point that is dependent upon the degree to which crystallization has progressed. However, once crystallized, the resin exhibits a melting point like other crystalline resins. In addition, as also demonstrated by the Declaration, unmodified YSLV-80XY as disclosed and used by Kawano, et al., exhibits an epoxy equivalent of 191 and a content ratio of n=0 of 93.6 where the higher component of n is n=1 which is further indicative of its crystalline nature and which does not conform to the stated limitations of the present invention as set forth in claim 1.

Thus, the data provided in the herewith filed Declaration clearly identifies the preferred resin of Kawano, et al. as a crystalline resin. Furthermore, nothing in Kawano, et al., suggests a non-crystalline resin having the properties recited in claim 1 as being suitable for use as the support in the fuel cell separator of Kawano, et al., such that there is no motivation, nor reasonable expectation of success, to one of ordinary skill in the art to conduct the experimentation necessary to sufficiently modify Kawano, et al., to obtain the non-crystalline resin of the present invention and determine its suitability for use in the manner disclosed in Kawano, et al.

Even if one were to apply the teachings of Hartmann to Kawano, et al., the level of motivation sufficient to support a finding of *prima facie* obviousness is lacking in view of Hartmann's overwhelming bias toward crystalline resin forms as shown by the Declaration.

As noted previously, Hartmann is directed to crystalline glycidyl ethers prepared by a reaction of 3,3',5,5'-tetraalkyl-4,4'-dihydroxybiphenyl and a halohydrin such as epichlorohydrin and neither teaches nor suggests a non-crystalline epoxy resin as recited in the presently amended claims having a molecular weight distribution comprising content of n=0 component which is 60% or less and an epoxy equivalent which is 250g/eq or over.

In contrast to the teaching of Hartmann, claims 1, 2, 5 and 8 as herein amended are directed to a non-crystalline epoxy resin which is obtained by reacting a liquid epoxy resin and an aromatic compound represented by general formula (1). Indeed, referring to Examples 1-3 of the present application, the liquid resin used as the precursor is that produced in Reference Example 1 from a crystalline diglycidylether resin of 3,3',5,5'-tetramethyl-4,4'-dihydroxyldiphenyl methane, heated to 100°C to fuse the crystalline structure to obtain the liquid form. In the present application, this liquid epoxy resin is then reacted with an aromatic compound represented by general formula (1), which may be an additional quantity of separately prepared 3,3',5,5'-tetramethyl-4,4'-dihydroxyldiphenyl methane, in the presence of nitrogen and butyltriphenylphosphoniumbromide, to obtain the non-crystalline solid or semi-solid resin. In that regard, Applicants respectfully submit that the present invention presents a composition that is different in structure and properties from that of Hartmann and which is produced by a method which is, essentially, a further process beyond that disclosed by Hartmann

since the liquid epoxy resin which is the precursor in the present invention is equivalent to the diglycidyl ether of 3,3',5,5'-tetraalkyl-4,4'-dihydroxybiphenyl product of Hartmann. Thus, since Hartmann neither discloses nor suggests such a further process treating the diglycidyl ether of 3,3',5,5'-tetraalkyl-4,4'-dihydroxybiphenyl product, Hartmann neither discloses nor suggests a non-crystalline epoxy resin produced by such further process and having the claimed properties. Accordingly, Hartmann fails to provide the teaching necessary to support a modification of Kawano, et al., to obtain the resin of the present invention as recited in claims 1, 2, 5 and 8.

Furthermore, since the tetramethyl bisphenol F epoxy resin of the Reference Example 1 of the present application is substantially the same as that disclosed by Kawano, et al., Applicants respectfully submit that Kawano, et al., merely discloses the resin used by Applicants as a reference against which the non-crystalline epoxy resin of the present application is compared. The reference neither discloses nor suggests the non-crystalline epoxy resin of the present invention prepared as recited in claim 1 and having a content of n=0 component of 60% or less and an epoxy equivalent of 250 g/eq or more. For the reasons given previously herein, the addition of the Hartmann reference does not cure the deficiencies of the Kawano, et al., reference since Hartmann fails to disclose or teach a non-crystalline epoxy resin represented by general formula (2) as recited in the present claims having the content of n=0 component

of 60% or less and an epoxy equivalent of 250 g/eq or more.

Whereas the teachings of a reference are not confined to the examples, the examples do provide guidance and instruction to one of ordinary skill in the art to understand and follow the teachings. Where the examples all lead in a single direction toward a single result, it is reasonable that one of ordinary skill will follow that lead in the absence of a clear suggestion to do otherwise. As noted previously, since the examples of Hartmann all lead one toward a single result, i.e., a crystalline resin, there is no motivation to modify that reference or, by extension, Kawano, et al., to achieve a different result, i.e., a non-crystalline resin as recited in the present claims.

Applicants point out that neither reference discloses a non-crystalline epoxy resin of general formula (2) where "n" is 0 or an integer of 2 or more in even numbers and having the claimed content of n=0 of at most 60% and an epoxy equivalent weight of at least 250. Thus, they fail to teach or suggest all of the claim limitations. To suggest that such a resin having those properties would be obvious from the prior art of record which is overwhelmingly directed to crystalline resins having significantly different contents of n=0 and epoxy equivalents would require those of ordinary skill to ignore the direction of the references and engage in a level of experimentation for which the references provide no reasonable expectation of success. Accordingly, there is no motivation for one to consider modifying the teachings of Hartmann and/or Kawano, et al., to obtain the

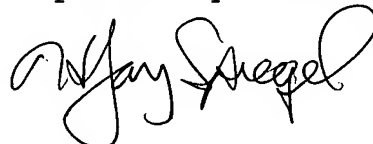
non-crystalline resin of the present invention. Nor is there anything to lead one to have any expectation of success if one were to do so.

In view of the foregoing, Applicants respectfully submit that a *prima facie* case of obviousness in view of Hartmann and/or Kawano, et al., has not been established with respect to the present claims.

Applicants respectfully submit that the non-crystalline epoxy resin of the present claims is neither disclosed nor suggested by the prior art nor are the improved results obtained with the epoxy of the present invention. Applicants therefore respectfully submit that the examiner's rejections of claims 1, 2, 5 and 8 over Hartmann alone or Kawano, et al., in view of Hartmann are without support and should be withdrawn and that the present application is now in condition for allowance.

An early notice of allowance is earnestly solicited.

Respectfully submitted,

A handwritten signature in black ink, appearing to read "H. Jay Spiegel", with a stylized, cursive script.

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